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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte ELLIE YIEH, LUDOVIC GODET, SRINIVAS NEMANI,
ER-XUAN PING, and GARY DICKERSON

Appeal 2019-005826
Application 15/356,475
Technology Center 2800

Before JAMES C. HOUSEL, DEBRA L. DENNETT, and LILAN REN,
Administrative Patent Judges.

HOUSEL, *Administrative Patent Judge.*

DECISION ON APPEAL

STATEMENT OF THE CASE

Pursuant to 35 U.S.C. § 134(a), Appellant¹ appeals from the Examiner's decision to reject claims 15–20. We have jurisdiction under 35 U.S.C. § 6(b).

We REVERSE, but enter NEW GROUNDS OF REJECTION,
37 C.F.R. § 41.50(b).

¹ We use the word Appellant to refer to “applicant” as defined in 37 C.F.R. § 1.42. Appellant identifies the real party in interest as Applied Materials, Inc. Appeal Brief (“Appeal Br.”) filed February 11, 2019, at 3.

CLAIMED SUBJECT MATTER

The invention relates to a method of filling a trench in a semiconductor wafer. Spec. ¶ 8. Appellant discloses that existing trench fill methods typically result in deposition of more material on top surfaces adjacent to the trench and on the trench's upper sidewalls than on its bottom and lower sidewalls. *Id.* ¶ 5. Such uneven deposition forms overhangs, which can cause the trench openings to close prior to completely filling the trench, resulting in voids within the trench. *Id.* To address this problem, Appellant teaches performing directional plasma treatment with an angled ion beam that etches a portion of sidewalls and top surface, but leaves the bottom untreated. *Id.* ¶¶ 8–10. In addition, Appellant's method may involve one or more cycles including material deposition followed by etching with one or more angled ion beams, to enable bottom-up trench filling without void formation. *Id.* ¶ 25.

Claim 15, reproduced below from the Claims Appendix to the Appeal Brief, is illustrative of the claimed subject matter:

15. A method of filling a trench in a semiconductor wafer, the method comprising:
 - depositing a material on the semiconductor wafer, filling a bottom of the trench and forming a layer on a sidewall of the trench and a top surface adjacent to the trench; and
 - etching the layer on the sidewall of the trench and the top surface with an ion beam at an angle with respect to the sidewall, wherein the etching does not entirely remove the layer from the sidewall and top surface of the trench.

REFERENCES

The Examiner relies on the following prior art:

Name	Reference	Date
Chen	US 6,750,116 B1	June 15, 2004
Lee et al. (“Lee”)	US 2006/0040485 A1	Feb. 23, 2006

REJECTION

The Examiner maintains, and Appellant requests our review of, the rejection of claims 15–20 under 35 U.S.C. § 103 as unpatentable over Lee in view of Chen.

OPINION

We review the appealed rejection for error based upon the issues Appellant identifies, and in light of the arguments and evidence produced thereon. *Ex parte Frye*, 94 USPQ2d 1072, 1075 (BPAI 2010) (precedential), *cited with approval in In re Jung*, 637 F.3d 1356, 1365 (Fed. Cir. 2011) (“[I]t has long been the Board’s practice to require an applicant to identify the alleged error in the examiner’s rejections.”). After considering the record before us, we are persuaded of reversible error in the pending rejection.

The Examiner finds that Lee teaches the method of filling a trench in a semiconductor wafer as recited in claim 15 except for a teaching the etching that does not entirely remove the layer from the sidewall and top surface of the trench. Final Act. 2. For this missing feature, the Examiner finds that Chen teaches a similar method wherein the etching does not entirely remove the layer from the sidewall and top surface of trench. *Id.* at 3. Therefore, the Examiner concludes that it would have been obvious to modify Lee’s method “to include the more selective removal of material as

taught by Chen, because different applications may benefit from having an asymmetrical trench fill/cap.” *Id.*

Appellant argues that the combination of Lee and Chen fails to result in a method including etching a layer on the sidewall and top of a trench with an angled ion beam, wherein the etching does not entirely remove the layer from the sidewall and top surface of the trench. Appeal Br. 7; *see also* Reply Br. 1–2. Appellant agrees with the Examiner that Lee fails to teach such partial etching, but contends that Chen fails to remedy this deficiency. Appeal Br. 8. In particular, Appellant asserts that Chen teaches a method of fabricating an asymmetric inner structure in contacts or trenches comprising an oxidation process to form a silicon dioxide layer over the sidewalls and bottom of a trench, implanting a dopant into the layer on one of the sidewalls and bottom of the trench by an angled ion implantation beam, followed by etching and removing the doped portion of the layer. *Id.* Appellant contends, therefore, that Chen forms a doped layer on a sidewall and bottom of the trench, and then etches this doped layer to entirely remove it. *Id.* As such, Appellant contends that Chen fails to teach forming a layer on a top surface, sidewalls and bottom of a trench, and etching the layer without entirely removing it from the sidewall and top surface of the trench. *Id.* at 8–9.

Appellant’s argument is persuasive of reversible error because, as Appellant contends, Chen fails to teach etching a layer formed on a sidewall and a top surface of the trench with an angled ion beam nor that such etching does not entirely remove the layer from the sidewall and top surface. The Examiner makes no finding that Chen etches the top surface of the trench nor that Chen etches with an angled ion beam, as required in claim 15. Instead, the Examiner focuses on Chen’s teaching that, after angled ion

implantation of a dopant in one of the sidewalls and bottom of the trench, etching removes only the doped layer from the sidewall, leaving intact the layer on the other sidewall and a layer on the top surface. Ans. 4. However, as Appellant argues, modification of Lee in view of Chen's teaching would not result in a method as recited in claim 15 because Chen does not teach angled ion beam etching a top surface of a trench that does not entirely remove the layer therefrom, nor angled ion beam etching a layer on a sidewall of a trench that does not entirely remove the layer from that sidewall. In the former case, Chen does not etch the top surface at all. In the latter case, Chen entirely etches a layer from one of the sidewalls, but does not etch at all a layer on the other sidewall.

Accordingly, we cannot sustain the Examiner's obviousness rejection of claims 15–20 over the combination of Lee and Chen.

However, contrary to the Examiner's finding, Lee specifically teaches that the angled ion beam etching may not entirely remove the layer from the sidewall and top surface of the structure to be filled. Lee ¶ 46 ("That is, the ion beam 116 is inclined relative to the main axis of the via hole 112 at an incident angle θ that is selected whereby the bottom surface of the via hole, and that portion of the phase change material 114 that will remain in the via hole, are protected from direct incidence of the ion beam."); ¶ 48 ("Alternatively, the IBE process S6 may be carried out under conditions and/or of limited duration sufficient to leave at least a portion of the phase change material layer 114 having a thickness on the top surface of the molding insulating layer 108."). Thus, Lee, paragraph 46, teaches that the incident angle θ of the ion beam may be selected so as to avoid etching the bottom as well as any portion of the layer formed in the structure that will

remain. Lee, paragraph 48, teaches that the conditions and duration of the ion beam etching also may be selected so as to leave at least some of the layer formed on the top surface of the structure. Therefore, it would have been obvious to an ordinary artisan to select the incident angle θ , the conditions, and the duration of Lee's ion beam etching such that the layer is not entirely removed from the top surface, sidewalls, or bottom of a structure to be filled. In addition, although Lee teaches that the structure to be filled is a via hole, rather than a trench, it would have been obvious to have used Lee's method to fill a trench because Lee addresses the same problem of overhangs creating defects during filling such as voids.²

We further find, as did the Examiner, that Lee teaches the subject matter of dependent claims 16–19. *See* Final Act. 3. Specifically, Lee teaches that multiple iterations of the deposition and etching steps may be performed to completely fill the structure, as recited in claim 16. Lee Fig. 7; ¶ 54. Lee also teaches that the incident angle θ , in most instances, may be range from 30° to 85°, which is within the range recited in claim 17. Lee ¶ 50. Lee further teaches that the incident angle θ varies depending on the aspect ratio of the structure to be filled and may be varied with each iteration. Lee ¶¶ 50–53. Therefore, it would have been obvious to arrive at the aspect ratio and the incident angle θ as recited in claims 18 and 19 to etch the necessary amount of the top of the sidewalls having the overhang as a matter of routine optimization. *In re Aller*, 220 F.2d 454, 456 (CCPA 1955) (“it is not inventive to discover the optimum or workable ranges by routine experimentation.”).

² In this regard, we note that Appellant does not contest the Examiner's finding that Lee teaches a method of filling a trench.

With regard to claim 20, Lee teaches filling the structure with a metal by sputtering. Lee ¶¶ 41–44. Although the Examiner finds, and Appellant does not dispute, that this teaching meets the limitations of claim 20, we find that Appellant admits that filling a trench via chemical vapor deposition (CVD), physical vapor deposition (PVD), plasma enhanced chemical vapor deposition (PECVD), or atomic layer deposition (ALD) was known. Spec. ¶ 5. Therefore, it would have been obvious to have modified Lee’s method to fill the trench using any of these known deposition techniques. *In re Fout*, 675 F.2d 297, 301 (CCPA 1982) (An express teaching need not be present in the art to support the substitution of one element for another element used for the same purpose.) The substitution of one known element for another would have been obvious when the combination yields no more than a predictable result, as here (i.e., using any of the known deposition techniques in Lee’s method). *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 416 (2007).

Accordingly, claims 15–19 are rejected under 35 U.S.C. § 103 as unpatentable over Lee, and claim 20 is rejected under 35 U.S.C. § 103 as unpatentable over Lee in view of Appellant Admitted Prior Art, Spec. ¶ 5 (“AAPA”). Because these rejections rely on findings either that the Examiner did not make or are contrary to the Examiner’s findings, we designate these as new grounds of rejection in accordance with 37 C.F.R. § 41.50(b).

CONCLUSION

Upon consideration of the record and for the reasons set forth above and in the Appeal and Reply Briefs, the Examiner’s rejection of claims 15–20 under 35 U.S.C. § 103 as unpatentable over Lee in view of Chen is *reversed*.

However, pursuant to 37 C.F.R. § 41.50(b), we enter the following as new grounds of rejection against claims 15–20:

Claims 15–19 are rejected under 35 U.S.C. § 103 as unpatentable over Lee; and

Claim 20 is rejected under 35 U.S.C. § 103 as unpatentable over Lee in view of AAPA.

DECISION SUMMARY

In summary:

Claims Rejected	35 U.S.C. §	Reference(s)/Basis	Affirmed	Reversed	New Ground
15–20	103	Lee, Chen		15–20	
15–19	103	Lee			15–19
20	103	Lee, AAPA			20
Overall Outcome					15–20

TIME PERIOD FOR RESPONSE

This decision contains a new ground of rejection pursuant to 37 C.F.R. § 41.50(b). 37 C.F.R. § 41.50(b) provides “[a] new ground of rejection pursuant to this paragraph shall not be considered final for judicial review.”

37 C.F.R. § 41.50(b) also provides that the Appellant, WITHIN TWO MONTHS FROM THE DATE OF THE DECISION, must exercise one of the following two options with respect to the new ground of rejection to avoid termination of the appeal as to the rejected claims:

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(1) *Reopen prosecution.* Submit an appropriate amendment of the claims so rejected or new Evidence relating to the claims so rejected, or both, and have the matter reconsidered by the examiner, in which event the prosecution will be remanded to the examiner. . . .

(2) *Request rehearing.* Request that the proceeding be reheard under § 41.52 by the Board upon the same Record. . . .

Further guidance on responding to a new ground of rejection can be found in the Manual of Patent Examining Procedure § 1214.01.

REVERSED; NEW GROUNDS OF REJECTION
37 C.F.R. 41.50(b)